DOCUMENT RESUME

ED 429 091 TM 029 628

AUTHOR	Staples, Jane G.; Luzzo, Darrell Anthony
TITLE	Measurement Comparability of Paper-and-Pencil and Multimedia Vocational Assessments. ACT Research Report Series 99-1.
INSTITUTION	American Coll. Testing Program, Iowa City, IA.
REPORT NO	ACT-RR-99-1
PUB DATE	1999-01-00
NOTE	71p.
AVAILABLE FROM	ACT Research Report Series, P.O. Box 168, Iowa City, IA 52243-0168.
PUB TYPE	Numerical/Quantitative Data (110) -- Reports - Research (143)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Career Counseling; Comparative Analysis; *Computer Assisted Testing; Equated Scores; Factor Analysis; Grade 12; Grade 9; *High School Students; High Schools; *Multimedia Materials; *Occupational Tests; Optical Data Disks; Tables (Data); *Test Format; Test Use
IDENTIFIERS	Paper and Pencil Tests

ABSTRACT

The purpose of this study was to determine the measurement comparability of paper-and-pencil and multimedia versions of two career assessment components in the DISCOVER multimedia career and education planning system. Students in grade 9 (N=606) and 11 (N=416) completed paper-and-pencil and Compact Disc-interactive (CD-i) versions of the Unisex Edition of the American College Testing Inventory (UNIACT) and the Inventory of Work-Relevant Abilities (IWRA). Measurement comparability of the versions was evaluated by comparing mean scale score differences, correlations between corresponding scales, and patterns of scale intercorrelations. In addition, targeted factor analyses were run for UNICAT and principal components analysis for UNIACT and IWRA. The results indicate that the use of pictures and voice-overs in the multimedia versions of the assessments yields scores comparable to those obtained with the paper-and-pencil versions. Appendixes contain the career guidance survey and a discussion of test equating. (Contains 4 figures, 18 tables, and 52 references.) (Author/SLD)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ACT Research Report Series 99-1

ED 429 091

Measurement Comparability of Paper-and-Pencil and Multimedia Vocational Assessments

Jane G. Staples

Darrell Anthony Luzzo

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Patricia Farrant

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

TM029628

BEST COPY AVAILABLE

ACT January 1999

For additional copies write:
ACT Research Report Series
PO Box 168
Iowa City, Iowa 52243-0168

© 1999 by ACT, Inc. All rights reserved.

Measurement Comparability of Paper-and-Pencil and Multimedia Vocational Assessments

Jane G. Staples
Darrell Anthony Luzzo

Erratum
for ACT Research Report 99-1

Please replace page iv with the following:

Acknowledgements

Several ACT staff members contributed to the study described in this report. Dale Prediger formulated the study's objectives and research design and specified the UNIACT targeted factor and related analyses. Kyle Swaney played an integral role in conducting the pilot study, determining the research designs, and serving as project manager for the Grade 9 phase of the study. Harold Engen recruited schools to participate in the study. Harold Engen and Donald Gaudreau assisted in data collection.

The authors of this research report are grateful to Kyle Swaney, Adam Burton, Dale Prediger, Timothy Vansickle, and James Sampson for their comments and suggestions regarding earlier drafts.

Table of Contents

Abstract iii

Acknowledgements iv

Introduction 1
Measurement Equivalence of Computerized Versions of Paper-and-Pencil Tests 1
Use of Pictures and Audio in Interest Inventories 4
Purposes of the Study 6

Method 7
Pilot Study 7
Samples 7
Instruments 8
Paper-and-pencil versions 8
Multimedia versions 9
Research Design 10
Procedures and Administration 10

Results and Discussion 12
Preliminary Analyses 12
Qualitative Comparability 13
Scale intercorrelations 13
Factor structure 14
Quantitative Comparability 16
UNIACT 16
IWRA 18
Reliability 18
UNIACT 18
IWRA 18

Summary and Conclusions 19

References 21

APPENDIX A. Career Guidance Survey 25

APPENDIX B. Equating 29

Tables 30

Figures 50

Abstract

The purpose of this study was to determine the measurement comparability of paper-and-pencil and multimedia versions of two career assessment components in DISCOVER. Grade 9 (N = 606) and 11 (N = 416) students completed paper-and-pencil and Compact Disc-interactive (CD-i) versions of the Unisex Edition of the ACT Interest Inventory (UNIACT) and the Inventory of Work-Relevant Abilities (IWRA). Measurement comparability of the versions was evaluated by comparing mean scale score differences, correlations between corresponding scales, and patterns of scale intercorrelations. In addition, targeted factor analyses were run for UNIACT and principal component analyses for UNIACT and IWRA. The results indicate that the use of pictures and voice-overs in the multimedia versions of the assessments yield scores comparable to those obtained with the paper-and-pencil versions.

Acknowledgements

Several ACT staff members contributed to the study described in this report. Dale Prediger provided direction and consultation throughout the study. Kyle Swaney played an integral role in conducting the pilot study, determining the research designs, and serving as project manager for the Grade 9 phase of the study. Harold Engen recruited schools to participate in the study. Harold Engen and Donald Gaudreau assisted in data collection.

The authors of this research report are grateful to Kyle Swaney, Adam Burton, Dale Prediger, Timothy Vansickle, and James Sampson for their comments and suggestions regarding earlier drafts.

Measurement Comparability of Paper-and-Pencil and Multimedia Vocational Assessments

There have been widespread changes in electronic and computer hardware, including the advent of laser disc technology. With the innovation and flexibility of Compact Disc-interactive (CD-i) and CD-ROM technologies, a range of multisensory options is possible; printed text can be combined with color photographs, CD-quality sound, and full-motion video sequences. These new technologies, when incorporated in computer-based career and educational planning systems, have the potential of offering counselees an enhanced career exploration experience (Sampson, 1997).

DISCOVER Multimedia (ACT, 1995a) is a career and educational planning system that operates on a CD-i player. DISCOVER for Windows (ACT, 1997) is a computer-based (CD-ROM) vocational guidance and information software system. The systems' two assessment components, the Revised Unisex Edition of the ACT Interest Inventory (UNIACT) and the Inventory of Work-Relevant Abilities (IWRA), add pictures and voice-overs to item text based on the established paper-and-pencil versions of these assessments. Determining whether the paper-and-pencil-based norms and validity data are applicable to the multimedia versions is worthy of empirical attention.

Measurement Equivalence of Computerized Versions of Paper-and-Pencil Tests

In 1986, the American Psychological Association (APA) published *Guidelines for Computer-Based Tests and Interpretations* to deal with such issues as the equivalence of computerized and paper-and-pencil tests. Equivalence is defined in Guideline 16 as:

> Scores from conventional and computer administrations may be considered equivalent when (a) the rank orders of the scores of individuals tested in alternative modes closely approximate each other, and (b) the means, dispersions, and shapes of the score

> distributions are approximately the same, or have been made approximately the same by rescaling the scores from the computer mode. (APA, 1986, p. 18)

According to Green (1991), cross-mode comparability studies reported in the literature typically involve comparing cross-mode scale correlations to determine whether the tests are measuring the same constructs. Low cross-mode correlations suggest that the tests are measuring different constructs. If there are high cross-mode scale correlations, comparisons of the means, standard deviations, and shapes of the score distributions are warranted. If the means, standard deviations, and shapes of distributions are different, the computer scores can be transformed or rescaled to the paper-and-pencil scores. Establishing test equivalence (and rescaling, if necessary,) allows computer scores to be interpreted using norms from the paper-and-pencil test. Furthermore, evidence of the validity of the paper-and-pencil version can be generalized to the computerized version.

In the area of noncognitive testing, equivalency studies involving personality inventories have yielded mixed results. Mazzeo and Harvey (1988) reviewed studies comparing the psychometric properties of computerized and paper-and-pencil tests. In the section of their review dealing with untimed personality inventories with single-screen items, they reviewed five studies that reported lower mean scores for the computerized versions of the *Minnesota Multiphasic Personality Inventory* and the *California Personality Inventory*. Mazzeo and Harvey noted that, although respondents could omit items in the paper-and-pencil mode, they were forced to answer all items in the computerized mode. They concluded that the observed mean score differences were due, in part, to the differential rate at which items are omitted. Equivalence was found in three studies involving five different psychological measures (e.g., *State-Trait Anxiety Inventory*, *Beck Depression Inventory*).

The results of equivalency studies involving career assessments have been unequivocal. In 1984, Brown (as cited in Hansen, 1987) examined profiles based on paper-and-pencil and computerized versions of the *Strong-Campbell Interest Inventory* (SCII) and found no significant mode of administration differences. O'Shea (1987) and Kapes and Vansickle (1992) compared computer and paper-and-pencil versions of the *Harrington-O'Shea Career Decision-Making System* (CDM). O'Shea found no significant mode of administration differences in means, standard deviations, or three-point codes. Kapes and Vansickle also found no systematic differences in means, standard deviations, or two-point codes; however, they did find that the computerized version was more reliable. Reardon and Loughead (1988) conducted an equivalency study of computer and paper-and-pencil versions of the *Self-Directed Search*. The cross-mode correlations for the six scales ranged from a low of .86 to a high of .94. Across modes, there were no significant differences in mean scores found for the six scale scores. Similarly, Vansickle, Kimmel, and Kapes (1989) and Vansickle and Kapes (1993) examined the equivalency of paper-and-pencil and computerized versions of the SCII. Results of both studies indicated that the two modes were equivalent; however, as discovered by Kapes and Vansickle with the CDM, the computerized version of the SCII was more reliable.

There are two noteworthy aspects of these equivalency studies. First, they compared paper-and-pencil and computerized versions of tests that did not include pictures or voice-overs. Second, most of these authors examined numerical score comparability by focusing on the scale mean and standard deviation differences.

In more recent equivalency studies (Van de Vijver & Harsveld, 1994; King & Miles, 1995) and reviews (Bugbee, 1996), the concept of equivalence has been further defined; empirically establishing that paper-and-pencil and computer versions of a test are measuring the same construct has emerged as a primary concern. According to Van de Vijver and Harsveld, computerized and

paper-and-pencil versions measure the same psychological construct(s) if they are structurally equivalent. They suggest that equivalency studies need to first assess the degree of factorial similarity by linear structural models or by a factor analysis of the item correlation matrix followed by a targeted rotation. In the latter approach, structural or qualitative equivalency is determined by comparing the number of factors and the factor loadings across administration modes. Given factorial similarity for the two modes of administration, evidence of numerical score comparability or quantitative equivalence can then be considered.

King and Miles' (1995) define measurement equivalence in terms of two elements: constant conceptual domain and constant calibration. Constant conceptual domain is assessed by establishing the two instrument versions have the same number of underlying factors. Constant calibration is assessed by testing for equality of factor loadings across administration modes. According to King and Miles, the former provides evidence the two versions measure the same construct while the latter provides evidence the two versions measure the same construct to the same degree. Furthermore, they suggest that comparison of mean score differences, without establishing evidence of a constant conceptual domain and constant calibration, is not meaningful and can be misleading.

Use of Pictures and Audio in Interest Inventories

DISCOVER Multimedia appears to be the first career planning system to administer interest and ability self-estimate items with accompanying color photographs and voice-overs. Nevertheless, the use of pictures and audio in interest assessment is not new.

Ammons, Butler, and Herzig (1950) developed a pioneering set of pictures portraying a variety of human activities in their study of vocational preferences. The approach was informal and involved the subject's projective statements about the pictures. The *Geist Picture Interest Inventory* (Geist, 1959) was the first formal pictorial interest inventory. It was developed in 1952 as an

alternative to verbal inventories that require a high level of verbal proficiency. Since then, a number of pictorial inventories have been developed (see Table 1). These instruments use line drawings, photographs, slides, or videos of tools, work environments, or individuals engaged in various work activities. Either items are presented in a forced-choice format or the counselee expresses a preference for each activity on a Likert scale. As noted in Table 1, many of the pictorial interest inventories were developed for special populations experiencing low reading ability; others were developed for the general population but are also described as appropriate for non-readers. The underlying premise is that pictorial representation of work environments, tools, or workers performing tasks is closer to real life (Geist, 1959), is less ambiguous (Jastak & Jastak, 1979), and is less open to interpretation (Becker, 1981).

For most of the assessments in Table 1, pictures are presented with no accompanying text. Two inventories combine written text or audible statements with pictures or videos. The *Interest-Based Career Decision* (IBCD; Peterson, 1994) inventory presents both pictures and written text; the pictures are included to augment the written items (Jim Roberts, personal communication 6/24/96). The 40-minute live action video in the *Career Assessment Battery* (CAB; Piney Mountain Press, 1991) was developed to correspond to the assessment used in the Kentucky State Career Information Systems. Information about the development of the video or its correspondence to the original assessment is not provided in either the CAB technical manual or the *CAB Technical Brief* (Piney Mountain Press, 1995).

Tétreau and Trahan (1983), developers of the *Tétreau-Trahan Visual Interest Test* (TTVIT: Tétreau & Trahan, 1986), conducted a study to determine the advantages of a pictorial versus verbal (i.e., written, paper-and-pencil) method of assessing interests. They developed verbal and pictorial forms that were parallel in content at the item level. The pictorial form consisted of 102 color slides of various occupations. The two forms were administered to 451 high school and college

students. Tétreau and Trahan reported that the alpha coefficients and mean scores obtained were "rather systematically, if slightly, higher for the TTVIT than for its verbal version, the differences being noticeably higher in the case of the female students" (p. 7). Corresponding scale correlations for the two modes yielded coefficients ranging from .78 to .91. Tétreau and Trahan concluded that the two forms measure "essentially the same dimensions" (p. 7). Information about the factor structure of the pictorial version is provided in the test manual; however, there is no information about the factor structure of the verbal version.

Although pictures have been used extensively in vocational assessments, very few assessments combine pictures with written text. Developers of those assessments have not conducted and reported equivalence studies. The Tétreau and Trahan (1983) study has peripheral relevance to the current study; they provided evidence of the quantitative equivalence of a pictorial interest inventory and a corresponding verbal version. The larger issue of whether introducing pictures and voice-overs to written text affects the psychometric properties (e.g., validity and reliability) of an assessment has not been addressed empirically.

Purposes of the Study

The primary purpose of this study was to evaluate the measurement comparability of the paper-and-pencil and multimedia versions of UNIACT and IWRA. Measurement comparability was evaluated by comparing correlations between corresponding scales, patterns of scale intercorrelations, and mean scale scores. In addition, targeted factor analyses were run for UNIACT and principal component analyses for UNIACT and IWRA. Given evidence of qualitative and quantitative comparability for the two modes of presentation, the validity evidence available for the paper-and-pencil versions of these instruments would be applicable to the multimedia versions.

The secondary purpose of the study pertained to norming of the multimedia versions of the two inventories. The scoring of these assessments involves the use of normative or scaling data

gathered via the administration of paper-and-pencil versions of the assessments to nationally representative samples (Swaney, 1995). Given evidence of measurement comparability, the data collected in this study can be used to equate multimedia scores to the existing paper-and-pencil-based scores, permitting paper-and-pencil-based norms to be used in scoring the multimedia versions of the two inventories.

Method

Pilot Study

In,March 1993, a pilot study was conducted using 9th-grade students enrolled in a Spanish class in a rural eastern Iowa school. The purposes of the pilot study were to (a) evaluate the administration instructions, (b) determine the time needed for students to respond to name, grade, and other background information items, and (c) determine the time needed for students to respond to CD-i items. The CD-i versions of UNIACT and IWRA were administered. In-class observations and tape recordings of the administration were used to estimate the per-item and total time needed to administer the CD-i versions of the two inventories.

Samples

Data collection was conducted in two phases. In the spring of 1993, data were collected from 9th-grade students. Nine of 12 Iowa schools contacted agreed to participate in the study. The 9th-grade sample of schools (see Table 2) included one urban alternative school, one urban parochial school, four urban public schools, and three rural public schools.

In the fall of 1993, data were collected from 11th-grade students. Four of the eight Iowa schools contacted agreed to participate in the study. The 11th-grade sample of schools (see Table 2) included one urban alternative school, one urban parochial school, and two suburban public schools. One of the suburban schools, due to its location, also enrolls rural and urban students.

In both phases of the study, school officials selected the classes (e.g., 9th-grade English, 11th-grade history) that would participate. As shown in Table 2, intact classes were assigned to one of two treatment groups (X and Y) described subsequently. In general, assignment of classes to groups alternated sequentially by class period. When school officials provided classes that varied on the basis of academic ability, there was an attempt to balance out the assignment to the two groups (X and Y) within and across schools. Students enrolled in those classes and present for both testing dates—regardless of grade level—were included in the 9th-grade (N = 606) and 11th-grade (N = 416) samples. The 9th-grade sample included 603 Grade 9 students and one each 8th-, 10th-, and 11th-grade students. The 11th-grade sample included 376 Grade 11 students and 40 Grade 12 students. Results of cross-tab analyses revealed the absence of a self-selection bias in the assignment of the 40 Grade 12 students to treatment groups. Table 3 summarizes selected characteristics of the samples.

Instruments

Paper-and-pencil versions. UNIACT (Swaney, 1995; see items in Appendix A) is a 90-item interest inventory designed to help persons identify personally relevant career options. Items emphasize work-relevant activities that are familiar to persons, either through participation or observation. A three-choice response format (*like, indifferent, dislike*) is used. The six 15-item scales correspond to Holland's (1997) six types. UNIACT scale titles (and corresponding Holland types) are Science (Investigative), Arts (Artistic), Social Service (Social), Business Contact (Enterprising), Business Operations (Conventional), and Technical (Realistic). Scores on the six scales are reported as stanines based on national norms. Internal consistency (Cronbach alpha) reliability estimates across UNIACT's six scales for a nationally representative sample of Grade 10 students ranged from .86 to .92 (median = .88) for males, and from .84 to .92 (median = .87) for females (Swaney, 1995). Grade 8 and 12 nationally representative samples yielded nearly identical

results to those for Grade 10. UNIACT validity data include Holland 3-letter codes for more than 79,000 persons in 648 career groups. Swaney (1995) provides specifics regarding UNIACT scale reliability and stability; convergent, discriminant, and criterion-related validity; and scoring.

IWRA (see Appendix A) obtains informed self-estimates for 15 abilities identified by research as important to occupational differentiation and success (ACT, 1999). The *Career Planning Survey Technical Manual* (ACT, 1999) describes how these abilities were identified and assigned to Holland's six types. Examples include numerical, mechanical, sales, leadership, and organizational abilities. Each ability is accompanied by a brief definition and examples of related activities. Respondents rate each ability on a scale of 1 to 5, with 1 = *low* (bottom 10%), 2 = *below average* (lower 25%), 3 = *average* (middle 50%), 4 = *above average* (upper 25%), and 5 = *high* (top 10%). The six IWRA scales have titles identical to those listed for UNIACT (see above). Four abilities are assigned to each scale, and 5 of the 15 abilities are assigned to more than one scale. Theory and research supporting these assignments is provided by Prediger (1992). Stanine-like scores (expressed to two digits) are provided for each scale through a validity-oriented scaling procedure described by Swaney (1987). Validity evidence supporting the use of IWRA in career counseling is described in the *Career Planning Survey Technical Manual* (ACT, 1999).

Multimedia versions. The CD-i versions of UNIACT and IWRA were presented on a television screen via a CD-i player. Because televisions used in the study were supplied by the schools, screen size varied from school to school but was never smaller than 21 inches.

For each UNIACT item, one visual representation of the activity is presented along with the item text on the screen. A voice-over reads the item text. For example, a visual representation of a young man engaged in calligraphy appears to the right of the text *Sketch and draw pictures.*

For each IWRA item, four visual representations for each ability appear sequentially on the screen at 3-second intervals as a voice-over reads the text. The visual representation appears to the

left of the text. Response options are displayed across the bottom of the screen. As an example, for the ability *Creative/Artistic*, the text reads *Drawing, painting, playing a musical instrument, acting, dancing, etc.* The following visual representations of the ability flash, one at a time, on the screen: A dancer dressed in a leotard dancing; painter painting a picture; sculptor working on a piece of sculpture; potter sitting at the wheel shaping a piece of pottery. The fourth and final visual representation for each item remains on the screen until the next item is selected.

Research Design

Figure 1 shows the designs used in collecting the 9th- and 11th-grade data. All students participating in the study completed the paper-and-pencil and CD-i versions of UNIACT and IWRA. Mode of presentation (CD-i and paper-and-pencil) for the two inventories was counterbalanced across Groups X and Y. Instrument sequence differed for the 9th and 11th graders. For Grade 9 students, instrument sequence was initially held constant (i.e., students completed UNIACT before IWRA). The research designed was modified (see Figure 1) after the ACT representative noted a substantial difference in individual reading speed. For approximately half of the sessions, the CD-I inventory was presented before the paper-and-pencil inventory. This modification affected only the instrument sequence, not the particular inventories planned for that session. Analyses of the Grade 9 data collected according to the initial research design did not show an instrument sequence effect. As shown in Figure 1, the modified Grade 9 research design was used in collecting the Grade 11 data.

Procedures and Administration

A school counselor or the classroom teacher introduced the ACT representative at the beginning of the first testing session in each classroom. The ACT representative told the students that ACT had two new multimedia vocational assessments that they were introducing to the 9th- or 11th-grade students in their school. For their participation, students were told they would receive

score reports for use in career planning. The representative provided each student with a copy of the *Career Guidance Survey* (*CGS*; see Appendix A), a machine-scorable answer sheet, and a pencil. Following directions on the front page of the *CGS*, students filled in their name, address, and other background questions on the answer sheet. Students were cautioned not to turn to other sections of the *CGS* until told to do so. Next, the students were shown the appropriate section of the answer sheet for recording their responses to one of the two inventories. (See Figure 1 for order and modes of presentation for the two inventories.) For CD-i presentations, the ACT representative asked the students to please look at the picture(s) for each item prior to marking their response on the answer sheet. The representative observed to make sure they finished recording their response before the next item was presented. When necessary, students were reminded to look at the screen before responding. After all of the students had recorded their response to the last item, those students who completed the CD-I version first were asked to turn to the appropriate page in the *CGS* and complete the other inventory. After all the answer sheets and *CGSs* had been collected, the representative thanked the students for their cooperation and indicated that they would be back for some additional testing in a week or so.

Approximately one to two weeks later, an ACT representative administered the two inventories in the appropriate order and mode as shown in Figure 1. After all of the answer sheets and *CGSs* had been collected, the ACT representative explained the purpose of the study and answered any questions. Subsequently, score reports based on the paper-and-pencil versions of UNIACT and IWRA were sent with interpretive materials to school counselors for use with the students.

Results and Discussion

Preliminary Analyses

Group and time-of-presentation (see research design in Figure 1) differences were examined to determine if the data for Groups X and Y could be collapsed, thus providing the maximum number of cases to determine the psychometric characteristics of the CD-i versions of the two inventories as well as the extent to which scores from the CD-i versions are related to scores from the paper-and-pencil versions. Tables 4 and 5 show the group and time-of-presentation mean scale score differences for UNIACT and IWRA at both grade levels.

The Grade 9 UNIACT group and time-of-presentation mean scale score differences are shown in Table 4, columns 5 and 10. For the six scales, the mean differences ranged from -0.6 to 0.3 for the CD-i presentation and -0.5 to 0.4 for the paper-and-pencil presentation. The mean absolute differences across the six scales were 0.3 for both modes of presentation. IWRA job cluster score mean differences (Table 5) ranged from -1.7 to 2.6 for the CD-i presentation and -3.7 to –0.4 for the paper-and-pencil presentation. The corresponding mean absolute differences for the six scales were 1.7 and 2.4, respectively. Comparing these differences to the corresponding time and group scale standard deviations (columns 2, 4, 7, and 9) provides a perspective of the magnitude of the differences. For example, the largest Grade 9 group and time-of-presentation mean absolute difference was 3.7; this difference was approximately one-fourth of the corresponding Business Contact (BC) group and time-of-presentation (paper-and-pencil) standard deviations of 14.7 and 15.6.

The Grade 11 group and time-of-presentation mean scale scores are also shown in columns 5 and 10 of Tables 4 and 5. For the six UNIACT scales, the mean differences were extremely small. The mean absolute difference across the six scales was 0.2 for both modes of presentation. IWRA job cluster score mean differences for group and time-of-presentation ranged from -1.8 to

3.6 for the CD-i presentation and from -3.3 to 0.6 for the paper-and-pencil presentation. The mean absolute difference for the six scales was 2.3 (CD-i presentation) and 2.2 (paper-and-pencil presentation). Again, when compared to the standard deviations for group and time-of-presentation (columns 2, 4, 7, and 9), these differences were small.

Given the small group and time-of-presentation mean differences, the data were collapsed across group and time-of-presentation for all subsequent analyses.

Qualitative Comparability

Scale intercorrelations. Cross-mode comparability was assessed by the correlations between corresponding scales. Scale intercorrelations simultaneously index the similarity of the rankings of examinees across modes and the degree of linearity of the relation between the two sets of scores. A low correlation would indicate nonlinearity or a cross mode difference in the constructs being assessed. As shown in Table 6, UNIACT cross-mode correlations ranged from .79 to .87 for Grade 9 and from .78 to .90 for Grade 11. For IWRA, the cross-mode correlation coefficients ranged from .71 to .78 and from .69 to .78 for Grades 9 and 11, respectively. The lower coefficients for the IWRA scales may have occurred because there are only four items per scale. The magnitudes of these correlation coefficients provide evidence that the two modes of presentation are assessing the same constructs.

UNIACT and IWRA scales are based on the typology and hexagonal structure of interests described in Holland's (1997) theory of careers. We would expect interest scales adjacent to each other on Holland's hexagon to be more highly correlated than non-adjacent scales, and scales located on opposite sides of the hexagon to have the lowest correlations. Intercorrelations among the six UNIACT scales for both paper-and-pencil and CD-i modes are shown in Table 7. The pattern of relationships for both modes was highly similar. The relative magnitudes of the adjacent, non-adjacent, and diagonal intercorrelations were generally in accord with Holland's theory.

Intercorrelations among IWRA job cluster scales are shown in Table 8. Ability intercorrelations were higher than interest intercorrelations, probably because 5 of the 15 abilities are assigned to more than one scale. The pattern of relationships for both modes was similar. Noteworthy departures from the hexagonal model for scale intercorrelations occurred for the Science (SC) scale. For both modes and grades, correlations between the SC scale and non-adjacent Business Contact (BC) and Business Operations (BO) scales were as high, or higher, than correlations between the Science (SC) scale and adjacent Arts (AR) and Technical (TE) scales. Reasons for this finding are unclear.

Factor structure. The structural or qualitative comparability of the CD-I and paper-and-pencil versions of UNIACT was examined by comparison of the theory-based dimensions underlying UNIACT. Research indicates that two theory-based dimensions, depicted in Figure 3, underlie Holland's two-dimensional hexagon. Empirical support for data/ideas and things/people work task dimensions is summarized by Prediger (1996) and Rounds (1995).

Cooley and Lohnes' (1971) targeted factor extraction procedure was used to compare the dimensions (principal component) from a set of intercorrelations. No factor rotation was involved. Instead, the program "causes the computer to respect the presumption of each factor as far as it can" (p. 137). The targeted factor extraction procedure was used to extract the two theory-based interest dimensions. The dimensions were defined by using the Cartesian coordinates in the hexagonal arrangement of Holland types to specify the relative sizes of the correlations expected between the six scales and the theory-based dimensions (Prediger, 1982). If the data/ideas and things/people dimensions fit the data perfectly, they should account for the maximum amount of variance that can be accounted for by any two interest dimensions. Principal component analyses provided the comparative data.

When all interest inventory items are scored in the same direction (e.g., *dislike, indifferent, like*), as in UNIACT, scores on interest scales are affected by response style. In the vocational interest domain, response style refers to systematic, non-interest-related differences in responses across counselees (e.g., some tend to choose *like* more often than others do) regardless of basic interest area (Prediger & Swaney, 1995). The primary identifying feature of a response style factor is that, in the initial factor matrix, all interest scales have relatively high loadings on the factor in question. Based on numerous intercorrelation matrices for instruments assessing Holland's types, Prediger (1982) showed that the response style factor often accounts for 40% or more of the total variance.

Principal component analyses were conducted on the four UNIACT scale intercorrelation matrices: Grade 9 CD-i, Grade 9 paper-and-pencil, Grade 11 CD-i, and Grade 11 paper-and-pencil. For comparison purposes, principal component analyses for the CD-i and paper-and-pencil presentations are shown side by side in Tables 9 and 10. Each of the principal component analyses yielded three orthogonal factors with eigenvalues of approximately one or greater than one. Together, the three factors accounted for 76% (Grade 9 paper-and-pencil), 74% (Grade 9 CD-i), 73% (Grade 11 paper-and-pencil), and 72% (Grade 11 CD-i) of the total variance. Across the four principal component analyses, the first factor—the Response Set factor—accounted for 32% to 39% of the variance. Across the four analyses, the pattern of factor loadings was very similar for corresponding factors. In each case, the pattern of loadings for the second and third factors was consistent with data/ideas and things/people dimensions, respectively. As noted earlier, these two dimensions provide the basis for explaining degree of structural comparability across the two modes. After variance accounted for by response style was removed, the remaining total percentage of variance accounted for by the second and third factors ranged from 32% to 35% for Data/Ideas, and from 24% to 27% for Things/People, respectively.

The same four UNIACT scale intercorrelation matrices were subjected to the targeted factor extraction procedure. The plotted factor loadings are shown in Figures 3 and 4. The hexagonal configurations of UNIACT scales on the Data/Ideas and Things/People factors were nearly identical for the paper-and-pencil and CD-i presentation modes. When plotted separately for males and females, the results were also very similar. The configurations approximated those reported by Swaney (1995) for two UNIACT national norming samples.

Tables 11 and 12 summarize the results of the targeted factor analysis. Across the four analyses, the factor loadings were very similar for corresponding factors. After variance associated with response style was removed, the remaining total percentage of variance accounted for by the theory-based dimensions was identical, or nearly identical, to that obtained via principal component analyses.

As noted earlier, IWRA scales are not independent; some of the items appear in more than one scale. Therefore, principal component and targeted factor analyses were not conducted at the *scale* level. However, IWRA principal component analyses were run at the *item* level, and the results suggest similar factor structure across modes within grade level.

Quantitative Comparability

UNIACT. Examining scale score differences for the two modes of presentation serves two purposes. Such an examination compares the extent to which the CD-i and paper-and-pencil scores are equivalent and allows for the identification of possible problematic CD-i items. UNIACT scale score mode of presentation differences were determined for the total group and for males and females.

UNIACT scale score means and standard deviations for the two modes are shown in Table 13. For Grade 9, the average mean scores were 5.3 for both paper-and-pencil and CD-i. Examined separately by scale, differences in mean scores between paper-and-pencil and CD-i

ranged from -0.2 to 0.2. Across the six scales, the mean absolute difference was 0.1. For Grade 11, three of the six UNIACT scale means were identical for the two modes. The mean differences for the three remaining scales ranged from -0.3 to 0.2. The mean absolute difference across the six scales was 0.1. These differences were extremely small relative to the corresponding scale standard deviations.

Male and female UNIACT mean raw scores are shown in Tables 14 and 15. The mode of presentation mean differences were extremely small. For Grade 9 males and females, the mean differences across the six scales ranged from -0.6 to 0.8 and -0.8 to 0.3, respectively. The absolute mean CD-i and paper-and-pencil differences for males (0.5) and females (0.4) were small. The mean differences across the six scales for Grade 11 males and females ranged from -0.5 to 1.3 and -0.4 to 0.7, respectively. The absolute mean differences for males (0.5) and females (0.3) also were small.

UNIACT items were carefully chosen to elicit similar response distributions from males and females (Prediger & Johnson, 1979; Swaney, 1995). Perspective on male-female score differences is provided by Dunnette's (1966) table for Tilton's (1937) measure of distribution overlap. Dunnette (1966) has suggested that two distributions are similar if their distributions overlap by more than 75% to 80%. Male-female overlap values for Grade 9 were 94% (SC), 86% (AR), 72% (SS), 93% (BC), 96% (BO), and 76% (TE) (mean = 86%) for paper-and-pencil and 92% (SC), 89% (AR), 72% (SS), 97% (BC), 96% (BO), and 77% (TE) (mean = 87%) for CD-i. Similar overlap values were obtained for Grade 11. The relative magnitudes of the six scale overlap percentages are highly consistent across the two modes of presentation. The ranges of percent overlap for the CD-i mode for Grade 9 (72%-97%) and Grade 11 (69%-98%) are also consistent with percent overlaps reported for UNIACT by Lamb and Prediger (1981) and Swaney (1995).

IWRA. For IWRA, there are two types of scaled scores to examine for mode of presentation mean differences. IWRA job cluster scale score mean differences are shown in Table 16. For Grades 9 and 11, the mean absolute across-mode differences for the six scales were 0.85 and 1.22, respectively. These differences were relatively small differences when compared to the magnitude of the scale standard deviations.

Tables 17 and 18 present the IWRA mean scaled scores for the 15 abilities for the two modes. Again, for both samples, mean score differences were extremely small. The largest mean difference (0.5) was approximately one fourth of the corresponding standard deviations.

The absence of appreciable differences for the two modes of presentation for UNIACT and IWRA suggests that the introduction of pictures and voice-over in the multimedia mode has little, if any, effect at the scale level. The paper-and-pencil and multimedia versions appear quantitatively comparable.

Reliability

UNIACT. Internal consistency reliability coefficients for the six UNIACT scales (see Table 13) were comparable for the paper-and-pencil and CD-i modes. For Grade 9, coefficient alphas (Cronbach, 1951) ranged from .84 to .91 for CD- i and from .86 to .92 for paper-and-pencil. The corresponding Grade 11 alphas ranged from .82 to .91 for CD-i and from .84 to .91 for paper-and-pencil.

IWRA. The coefficient alphas for the IWRA job cluster scales (see Table 16) ranged from .51 to .63 for CD-i and from .58 to .66 for paper-and-pencil for Grade 9. For Grade 11, coefficient alphas ranged from .47 to .60 for CD-i and from .49 to .67 for paper-and-pencil. The lower coefficients for the ability scales may have occurred due to the sensitivity of coefficient alpha to the number of items in a scale (Cortina, 1993) and the fact that the items in the scales were not selected to be homogeneous. Each ability scale consists of only four abilities—albeit abilities shown to be

important to occupations in the corresponding job cluster (Prediger, 1992). Several studies (e.g., Prediger & Brandt, 1991; Prediger & Swaney, 1992) have demonstrated the validity of the ability scales for use in career exploration.

Summary and Conclusions

The American Psychological Association's *Guidelines for Computer-Based Tests and Interpretations* (1986) deal specifically with comparability of paper-and-pencil and computerized tests. By extension, these guidelines and the suggestions of Green (1991), Van de Vijver and Harsveld (1994), and King and Miles (1995) were used as a basis for determining the comparability of paper-and-pencil and multimedia versions of two assessments. At this point in time, the multimedia versions of UNIACT and IWRA appear to be unique; few of the aural/pictorial assessments in Table 1 combine written text, voice-overs, and pictures. In evaluating the qualitative comparability of verbal and pictorial forms of the TTVIT, Tétreau and Trahan (1986) provide a point of comparison. Tétreau and Trahan reported scale intercorrelations (i.e., .78 to .91) that were highly similar to those obtained in this study (see Table 6).

The primary purpose of this study was to evaluate the qualitative and quantitative comparability of the multimedia and paper-and-pencil versions of UNIACT and IWRA. The high cross-mode scale correlations lend support to the qualitative comparability for both UNIACT and IWRA, and the absence of appreciable mean scale differences indicates that the paper-and-pencil and multimedia versions are quantitatively comparable. For UNIACT, there is additional evidence of the qualitative comparability. The pattern of scale intercorrelations generally corresponds to theoretical expectations. The two-dimensional plots of the factor scores are nearly identical for the two modes, and approximate the theory-based hexagonal configuration.

Given the degree of qualitative and quantitative comparability of the multimedia and paper-and-pencil versions found here, it is appropriate to equate multimedia scores to existing paper-and-

pencil-based scores. The rescaling procedure is described in Appendix B. [It should be noted that ACT recently revised the scoring procedure for IWRA (norming at the scale level vs. the item level).]

This finding of measured comparability in the scores based on the paper-and-pencil and multimedia versions of UNIACT and IWRA is important for users and practitioners. The multimedia versions of DISCOVER provide counselees with an enhanced career exploration experience. Special populations, such as individuals with disabilities or reading deficiencies, can use these assessments in career exploration and planning. Users and practitioners can have confidence in the reliability and validity of the multimedia versions.

A potential limitation of this study is that the multimedia versions of the two assessments were administered in a group situation; students recorded their responses on an answer document. Use of an answer document was necessary to capture item responses. Also, this approach yielded desired sample sizes in an efficient manner. Typically, counselees using DISCOVER Multimedia or DISCOVER for Windows would indicate their responses by pointing and clicking or by keystrokes, respectively. Future studies of comparability might compare DISCOVER (1995b) with DISCOVER for Windows (1997) versions of UNIACT and IWRA.

References

Achtnich, M., & Filho, J. F. (1994). The Berufsbildertest: Vocational Pictures. *The Career Development Quarterly, 42*, 262-270.

ACT, Inc. (1995a). *DISCOVER multimedia: Professional manual.* Hunt Valley, MD: Author.

ACT, Inc. (1995b). *DISCOVER for high schools: Professional manual.* Hunt Valley, MD: Author.

ACT, Inc. (1997). *DISCOVER for Windows: Professional manual.* Hunt Valley, MD: Author.

ACT, Inc. (1999). *Career Planning Survey technical manual.* Author: Iowa City, IA.

Ammons, R. B., Butler, M. N., & Herzig, S. A. (1950). A projective test for vocational research and guidance at the college level. *Journal of Applied Psychology, 34*, 198-205.

American Psychological Association. (1986). *Guidelines for computer-based tests and interpretations.* Washington, DC: Author.

Becker, R. L. (1988). *Reading-free Vocational Interest Inventory manual* (revised). Columbus, OH: Elbern.

Bugbee, A. C. The equivalence of paper-and-pencil and computer-based testing. *Journal of research on computing in education, 28*, 282-299.

Career Resource Center. (1981). *Comparative Career Search user's manual.* South Bend, IN: Author.

Cooley, W. W., & Lohnes, P. R. (1971). *Multivariate data analysis.* New York: Wiley.

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*, 98-104.

Cronbach, L. J. (1951). Coefficient alpha and internal structure of tests. *Psychometrika, 12*, 297-334.

Dunnette, M. D. (1966). *Personnel selection and placement.* Belmont, CA: Wadsworth.

Geist, H. (1959). The Geist Picture Interest Inventory: General form: Male. *Psychological Reports, 5*, 413-438.

Green, B. F. (1991). Guidelines for computer testing. In T. B. Gutkin, & S. L. Wise (Eds.), *The computer and the decision-making process.* Hillsdale, NJ: Erlbaum.

Hansen, J. C. (1987). Computer-assisted interpretation of the Strong Interest Inventory. In J. N. Butcher (Ed.), *Computerized psychological assessment: A practitioner's guide* (pp. 292-321). New York: Basic Books.

Holland, J. L. (1997). *Making vocational choices* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

Jastak, J. F., & Jastak, S. (1979). *Wide Range Interest-Opinion Test Manual.* Wilmington, DE: Jastak Associates.

Kapes, J. T., Mastie, M. M., & Whitfield, E. A. (Eds.). (1994). *A counselor's guide to career assessment instruments* (3rd ed.). Alexandria, VA: The National Career Development Association.

Kapes, J. T., & Vansickle, T. R. (1992). Comparing paper-and-pencil and computer-based versions of the Harrington-O'Shea Career Decision-Making System. *Measurement and Evaluation in Counseling and Development, 25,* 5-13.

King, W. C., Jr., & Miles, E. W. (1995). A quasi-experimental assessment of the effects of computerizing noncognitive paper-and-pencil measurements: A test of measurement equivalence. *Journal of Applied Psychology, 80,* 643-651.

Knapp-Lee, L. (1993). *COPS Picture Inventory of Careers examiner's manual.* San Diego, CA: Educational Research and Services.

Kolen, M. J. (1984). Effectiveness of analytic smoothing in equipercentile equating. *Journal of Educational Statistics, 9,* 25-44.

Lamb, R. R. & Prediger, D. J. (1981). *Technical report for the unisex edition of the ACT Interest Inventory (UNIACT).* Iowa City, IA: ACT, Inc.

Mazzeo, J., & Harvey, A. L. (1988). *The equivalence of scores from automated and conventional educational and psychological tests: A review of the literature* (College Board Report No. 88-8). New York: College Board.

O'Shea, A. J. (1987). *A comparison of microcomputer and paper-pencil career interest inventory administration.* Alexandria, VA: American Association for Counseling and Development.

Peterson, G. W. (1994). A review of the Interest Based Career Decision (IBCD) inventory. In J. T. Kapes, M. M. Mastie, & E. A. Whitfield (Eds.), *A counselor's guide to career assessment instruments* (3rd ed., pp. 82-85). Alexandria, VA: National Career Development Association.

Piney Mountain Press, Inc. (1995). *Career Assessment Battery technical brief.* Cleveland, GA: Author.

Piney Mountain Press, Inc. (1991). *Career Assessment Battery technical manual.* Cleveland, GA: Author.

Prediger, D. J. (1982). Dimensions underlying Holland's hexagon: Missing link between interests and occupations? *Journal of Vocational Behavior, 21*, 259-287.

Prediger, D. J. (1992, March). Identifying and assigning abilities to ACT Job Clusters and Holland's occupational types. In D. Prediger (Chair), *Beyond the "ASVAB code": Using the other ASVAB scores to expand career exploration.* Symposium conducted at the meeting of the American Counseling Association, Baltimore.

Prediger, D. J. (1996). Alternative dimensions for the Tracey-Rounds interest sphere. *Journal of Vocational Behavior, 48,* 59-67.

Prediger, D. J., & Brandt, W. E. (1991). Project CHOICE: Validity of interest and ability measures for student choice of vocational program. *Career Development Quarterly, 40,* 132-144.

Prediger, D. J., & Johnson, R. W. (1979). *Alternatives to sex-restrictive vocational interest assessment* (ACT Research Report No. 79). Iowa City, IA: ACT, Inc.

Prediger, D. J., & Swaney, K. B. (1992). *Career counseling validity of DISCOVER's job cluster scales for the revised ASVAB score report* (ACT Research Report No. 92-2). Iowa City, IA: ACT, Inc.

Prediger, D. J., & Swaney, K. B. (1995). Using UNIACT in a comprehensive approach to assessment for career planning. *Journal of Career Assessment, 3,* 429-451.

Reardon, R., & Loughead, T. (1988). A comparison of paper-and-pencil and computer versions of the Self-Directed Search. *Journal of Counseling and Development, 67,* 249-252.

Rounds, J. (1995). Vocational interests: Evaluating structural hypotheses. In D. Lubinski & R. V. Dawis (Eds.), *Assessing individual differences in human behavior: New concepts, methods, and findings.* Palo Alto, CA: Davies-Black.

Sampson, J. P., Jr. (October, 1997). Enhancing the use of career information with computer-assisted career guidance systems. In *The present and future of computer-assisted career guidance systems in Japan.* Symposium conducted at the Japan Institute of Labor.

Siefker, J. M. (1996). *Tests and test use in vocational evaluation and assessment.* Menomonee, WI: Stout Vocational Rehabilitation Institute, University of Wisconsin-Stout.

Swaney, K. B. (1987). *The DISCOVER self-estimates abilities study: Methods and results.* Unpublished manuscript, Iowa City, IA: ACT, Inc.

Swaney, K. B. (1995). *Technical manual: Revised Unisex Edition of the ACT Interest Inventory (UNIACT).* Iowa City, IA: ACT, Inc.

Tétreau, B., & Trahan, M. (April, 1983). *The measurement of vocational instruments through pictorial stimuli.* Paper presented at the 67th Annual Meeting of the American Educational Research Association in Montreal, Quebec.

Tétreau, B., & Trahan, M. (1986). *Test Visuel d'Intérêts Tétreau-Trahan: Manuel d'usage* (2nd ed.). Montreal: SECOREP, Inc.

Tilton, J. W. (1937). Measurement of overlapping. *Journal of Educational Psychology, 28,* 656-662.

U. S. Department of Labor. (1991). Dictionary of occupational titles (4th ed., rev.). Washington DC: U.S. Government Printing Office.

Van de Vijver, F. J. R., & Harsveld, M. (1994). The incomplete equivalence of the paper-and-pencil and computerized versions of the General Aptitude Test Battery. *Journal of Applied Psychology, 79,* 852-859.

Vansickle, T. R., & Kapes, J. T. (1993). Comparing paper-pencil and computer-based versions of the Strong-Campbell Interest Inventory. *Computers in Human Behavior, 9,* 441-449.

Vansickle, T. R., Kimmel, C., & Kapes, J. T. (1989). Test-retest equivalency of the computer-based and paper-pencil versions of the Strong-Campbell Interest Inventory. *Measurement and Evaluation in Counseling and Development, 22,* 88-93.

Wilbourn, J. M., & Alley, W. E. (1978). *Pictorial Interest Inventory development* (AFHRL-TR-78-36). Madera, CA: Select Press.

Wilgosh, L. (1991). The Audiovisual Vocational Preferences Test: A report of test development. *Canadian Journal of Rehabilitation, 5,* 17-23.

APPENDIX A

CAREER GUIDANCE SURVEY

Instructions for Completing the Answer Sheet

Because your answer sheet will be processed by computer, please use a No. 2 pencil and print clearly. Blacken each circle completely, making sure all marks are dark. Completely erase any changes. Do not fold your answer sheet.

Block A, Name: Print your name in the large boxes labeled Last Name, First Name, MI (middle initial). Begin in the first box for each part of your name. Enter as much of your name as possible, using one box per letter. Do not extend any part of your name into the boxes reserved for another part of your name.

Next, blacken the correct circles below each letter of your name.

Block B, Date of Birth: Blacken the correct circle for your month. Then enter the numbers for your day and year in the boxes.

Next, blacken the correct circles below each number.

Block C: Skip this block.

Block D, Sex: Blacken the correct circle--M for male, F for female.

Block E, Racial/Ethnic Group: Which of the phrases below best describes your racial/ethnic group as generally recognized by your family and friends? Blacken the correct circle on the answer sheet.

1. African-American/Black
2. American Indian, Alaskan native
3. Caucasian-American/White
4. Mexican-American/Chicano
5. Asian-American, Pacific Islander
6. Puerto Rican, Cuban, other Hispanic origin
7. Other
8. I prefer not to respond.

Block F, Grade: Blacken the correct circle for your grade level.

Skip blocks **G, H, and I.**

©1993 by American College Testing, Iowa City, Iowa. All rights reserved.

Ability Self-Estimate Inventory

This inventory will help you estimate your standing on 15 important abilities. We will provide you with a report that relates your abilities to the four basic work tasks--working with DATA, PEOPLE, THINGS, and IDEAS. The report will also suggest occupations in line with your abilities. The suggestions will only be as good as the accuracy of your ability estimates.

1st: For each ability, carefully read the examples of related activities. Then estimate your ability compared to persons your own age. Use the numbers in the box below.

5 = high (top 10%)
4 = above average (upper 25%)
3 = average (middle 50%)
2 = below average (lower 25%)
1 = low (bottom 10%)

2nd: Blacken the circle for your estimate on your answer sheet. Erase completely any estimate you change.

Ability	Examples of Activities
1. **Meeting People**	**Talking with people; getting along with others; making a good impression.** Consider your ability to help people feel at ease; to be courteous, pleasant, or informative; to remember names and faces.
2. **Helping Others**	**Caring for or teaching others; helping people with problems or decisions.** Consider your ability to explain how to do something; to understand the ideas and feeling of others; to help someone feel better; to be tactful and patient.
3. **Sales**	**Influencing people to buy a product, service, or take a suggested course of action.** Consider your ability to change someone's mind; to bargain; to make a sale; to persuade a group; AND how you did in speech, debate, distributive education, marketing, etc.
4. **Leadership (Management)**	**Leading/managing people so that they work toward a common goal.** Consider your ability to present ideas to a group; to motivate others and provide direction; to plan an event; to stick to a budget.
5. **Organization**	**Keeping track of tasks and details; doing things in a systematic way.** Consider your ability to keep to a schedule; to see what needs to be done first, second, etc.; to store things (pictures, clippings, tools, etc.) so they are easy to find.
6. **Clerical**	**Quickly and accurately doing tasks such as looking up information in catalogs or tables, sorting things, recording addresses or expenses, etc.** Consider your ability to handle paperwork; to type; to complete forms accurately and neatly (e.g., an application); to catch errors.
7. **Mechanical**	**Understanding everyday mechanical laws (e.g., warm air rises) and how simple mechanical things work (e.g., a lever, a pulley).** Consider how easily you figure out how things work (toys, tools, appliances, etc.) and how to fix them; AND how you did in general science, industrial arts, home economics, shop.

5 = high (top 10%)
4 = above average (upper 25%)
3 = average (middle 50%)
2 = below average (lower 25%)
1 = low (bottom 10%)

Ability	Examples of Activities
8. Manual Dexterity	**Making or repairing things easily and quickly with one's hands.** Consider your ability to handle tools, appliances, or to assemble things (toys, furniture, picture frames, etc.); to do handicrafts; to handle or connect small objects; to use your coordination; AND how you did in industrial arts, home economics, shop.
9. Numerical	**Doing arithmetic accurately and quickly; applying arithmetic (e.g., in formulas and word problems).** Consider how you did in arithmetic when studied in various classes; your skill with a calculator, in keeping track of expenses, in figuring interest rates, or in finding the "best buy," etc.
10. Scientific	**Understanding science laws; doing science course work.** Consider your ability to use math rules and formulas; to understand articles or TV programs on science, health, or technology; AND how you did in classes such as general science, chemistry, biology, etc.
11. Creative/Artistic	**Drawing, painting, playing a musical instrument, acting, dancing, etc.** Consider how well you can express ideas, feelings, or moods through one or more of the performing arts; AND how you did in classes such as art, music, dance--either in or out of school.
12. Creative/Literary	**Expressing ideas or feelings through writing.** Consider your ability to write interesting letters to friends or family members; to write reports, explanations of events, opinions, etc.; AND how you did on themes in English and in other classes.
13. Reading	**Reading and understanding factual material (for example, in a textbook or manual).** Consider your ability to finish reading assignments (speed and understanding); to read directions or warranties for a tool, appliance, TV, etc.; to follow news stories in magazines, editorials, etc.
14. Language Usage	**Recognizing correct and incorrect uses of the English language (grammar, punctuation, etc.).** Consider your ability to write and speak correctly; to organize and present your thoughts; AND how you did in classes such as English and speech.
15. Spatial Perception	**Looking at a drawing of an object (e.g., a house, coat, tool) and picturing in your mind how it would look from different sides.** Consider your ability to "read" and explain blueprints, clothing patterns, etc.; to see how things could fit within the available space (a box, room, closet, etc.).

NEXT: Look over your estimates to see if they show how your abilities rank--top to bottom. Carefully erase any estimate you wish to change and blacken the circle for your revised estimate.

The ACT Interest Inventory

The things you like to do now can give you clues about jobs you might like. This inventory will help you identify occupations you may want to explore. We will provide you with a report that relates your interests to the four basic work tasks--working with DATA, PEOPLE, THINGS, and IDEAS. The report will also suggest occupations in line with your interests.

Show how much you would like doing each of the activities listed below. Mark an answer to an activity even if you are uncertain how you feel about it. Consider whether you would **like** or **dislike** the activity, not your ability to do it.

For each activity, choose one of the answers below. Blacken the circle on your answer sheet that contains the letter for your answer. Try to answer **like** or **dislike** as often as possible.

I would **dislike** doing this activity.....D
I am **indifferent**.....I
I would **like** doing this activity.....L

1. Learn about star formations
2. Sketch and draw pictures
3. Help someone make an important decision
4. Conduct a meeting
5. Count and sort money
6. Build a picture frame
7. Learn how the brain works
8. Compose or arrange music
9. Give first aid to an injured person
10. Develop new rules or policies
11. Take inventory in a store
12. Fix a toy
13. Explore a science museum
14. Make creative photographs
15. Show children how to play a game or sport

16. Work in a political campaign
17. Write payroll checks
18. Run a lawn mower
19. Attend the lecture of a well-known scientist
20. Write short stories
21. Work on a community improvement project
22. Present information before a group
23. Set up a bookkeeping system
24. Watch for forest fires
25. Study biology
26. Read about the writing style of modern authors
27. Help a newcomer meet people
28. Discuss a misleading advertisement with a salesperson
29. Prepare a budget for a club or group
30. Build furniture

31. Measure chemicals in a test tube
32. Prepare drawings to illustrate a magazine story
33. Take part in a small group discussion
34. Plan work for other people
35. Balance a checkbook
36. Learn to cut and polish gemstones
37. Read about a new surgical procedure
38. Write a movie script
39. Find out how others believe a problem can be solved
40. Explain legal rights to people
41. Sort, count, and store supplies
42. Repair damage to a tree after a storm
43. Study plant diseases
44. Select music to play for a local radio station
45. Help rescue someone in danger

46. Demonstrate a new product
47. Plan a monthly budget
48. Design a bird feeder
49. Read books or magazines about new scientific findings
50. Play jazz in a combo
51. Help settle an argument between friends
52. Campaign for a political office
53. Find errors in a financial account
54. Engrave lettering or designs on a trophy or plaque
55. Study chemistry
56. Draw cartoons
57. Give directions to visitors
58. Publicize a show or athletic event
59. Figure shipping costs for catalog orders
60. Operate a slide or movie projector

61. Use a microscope or other lab equipment
62. Design a metal sculpture
63. Help friends with their problems
64. Conduct business by phone
65. Make charts or graphs
66. Learn how to repair a typewriter
67. Read about the origin of the earth, sun, and stars
68. Play in a band
69. Teach people a new hobby
70. Interview workers about company complaints
71. Calculate the interest on a loan
72. Watch a technician repair a television
73. Observe and classify butterflies
74. Write reviews of Broadway plays
75. Help people during emergencies

76. Hire a person for a job
77. Keep expense account records
78. Prune plants and shrubs
79. Study the effects of vitamins on animals
80. Design a poster for an event
81. Entertain others by telling jokes or stories
82. Manage a small business
83. Look for errors in the draft of a report
84. Shelve books in a library
85. Learn how birds migrate
86. Play a musical instrument
87. Give a tour of an exhibit
88. Conduct a door-to-door opinion poll
89. Operate office machines
90. Inspect products for defects

BEST COPY AVAILABLE

APPENDIX B

Equating

For both UNIACT and IWRA, the scores of the multimed dia version were equated to the paper-and-pencil version using an equipercentile method of equating. I n the 9th-grade sample 606 students completed both UNIACT and IWRA via the two modes of admin istration in a counterbalanced design. In the 11th-grade sample, 416 students completed IWRA and UN IACT via the two modes of administration.

In equating the multimedia to the paper-and-pencil forms, cumulative percent distributions of scores for both forms were prepared and the data were used to loc cate points below which equal proportions of the distributions fell. A conversion curve was ther n drawn and the equivalent scores were read from this curve. Since this procedure does not usually result in the smooth curve that would be expected to display the relationship between the scores on two forms of a test, a method of analytically smoothing using cubic spline functions (Kolen, 1984) was employed. The conversion table that results from this process was then used to transform sc ores from the multimedia mode of administration to scale scores.

TABLE 1

Pictorial Interest Inventories

Inventory	Latest manual/ guide revision	Target population	Format	Scoring
Audiovisual Vocational Preference Test[a]	Currently in press	Adolescent and young adults with mild to moderate mental disabilities	Forced-choice format with videotape showing ten entry-level job sites for individuals with mental disabilities; taped audio directions	Test administrator counts the individual's selections
Career Assessment Program: Interest-Based Career Decision (IBCD)[b]	1988	Paper-and-pencil and computer versions for Grade 6 and above; audio-visual version for special populations	4-point Likert scale (*Dislike Very Much* to *Like Very Much*); paper and pencil, audio-visual, and black-and-white computerized versions; 200 items consisting of verbal statements of job tasks and pictures of individuals performing the tasks	20 work dimensions; profiles show ratings of *avoid*, *neutral*, or *approach* and a match to 11 interest areas
Career Assessment Battery (CAB)[b]	1991	Grade 8-adult; non-readers	Respondents circle choices in workbook as they view a narrative videotape depicting 101 occupational situations.	12 worker trait clusters
Career Occupational Preference System Picture Inventory of Careers (COPS-PIC)[c]	1993	General population; non-reading, learning disabled, and non-English-speaking adults	4-point Likert scales (*Like Very Much, Like Moderately, Dislike Moderately,* and *Dislike Very Much*); 168 realistic pictures of job activities	14 career clusters
Comparative Career Search[d]	1981	Age 12-adult	Forced-choice format with 72 color slides consisting of 2 photographs and 2 line drawings of persons performing contrasting work tasks; audio cassette contains directions	Holland's 6 types

(table continues)

Inventory	Latest manual revision	Target population	Format	Scoring
Explore the World-of-Work (E-WOW)[b]	1991	Adults with low reading level in adult retraining and re-entry programs	36 graphics depicting 24 work activities and 12 work values; 3-point (coloring) Likert scale	Respondents visually review items selected (i.e., *Like*)
Geist Picture Interest Inventory: Revised (GPII-R)[e]	1988	Grade 8 through adult; culturally different and educationally deprived	Forced-choice format; 27 triads (female) and 44 triads (male) using line drawings	11 interest scores for males, 12 interest scores for females
Pictorial Inventory of Careers (PIC)[b]	1992	Low functioning and regular vocational students ages 13-55	5-point Likert scales (*Strongly Like* to *Strongly Dislike*); 210 35mm color slides	21 occupational clusters
Pictorial Interest Inventory (PII)[f]	1980	Air Force enlistees	3-point Likert scale (*Like, Indifferent, Dislike*); 180 35mm color slides	11 interest scales for females; 12 interest scales for males
Picture Interest Exploration Survey (PIES)[b]	1974	Grades 7-12; non-readers	156 slides depicting a worker's hand performing a task that represents a particular occupation	13 occupational areas
Reading-Free Vocational Interest Inventory (R-FVII)[g]	1988	Mentally retarded, learning-disabled, and disadvantaged from age 13 to adult	Forced-choice format; 55 triads using 165 line drawings	12 interest areas limited to occupations typically held by target population
Tétreau-Trahan Visual Interest Test (TTVIT)[h]	1986	High school students and adults in Canada and Brazil; different linguistic, cultural, and socioeconomic backgrounds	5-point Likert scale (*Dislike Very Much* to *Like Very Much*); 102 color slides of real-life occupational activity	Holland's 6 types

(table continues)

Inventory	Latest manual revision	Target population	Format	Scoring
Vocational Pictures Technique (VPT)[i], aka the Berufsbildertest	1979	Career counseling clients	96 photographs of workers in action are sorted into like/indifferent/dislike groupings, and within grouping in order of importance.	The respondent selects the five most important photographs and tells a story.
Wide Range Interest Opinion Test (WRIOT)[j]	1979	Age 5 through adult	Forced-choice format with 150 triads; also available on 35mm filmstrip	18 interest clusters
Work Activities Checklist[b]	1986	High school students	Filmstrip depicting 10 basic types of work activities	10-item checklist used to identify preferences for work activities
World-of-Work inventory (WOWI)[b]	1987	High school through adult	3-point Likert scale (*Like, Neutral, Dislike*); 238 items administered via paper-and-pencil or computer modes. Graphic material and illustrations appear only in the test booklet.	17 Basic Occupational Areas in the *Dictionary of Occupational Titles*[k]

Note. Information about the inventories included in this table was obtained via a comprehensive literature review.
[a]Wilgosh (1991). [b]Kapes, Mastie, and Whitfield (1994). [c]Knapp-Lee (1993). [d]Career Resource Center. (1981). [e]Siefker (1996). [f]Wilbourn and Alley (1978). [g]Becker (1988). [h]Tétreau and Trahan (April, 1983). [i]Achtnich and Filho (1994). [j]Jastak and Jastak (1979). [k]U.S. Department of Labor (1991).

TABLE 2

Schools, Testing Dates, and Sample Sizes

School	Type of community	Testing interval (days)	Students in study	Sample Sizes			
				Group X		Group Y	
				Number of classrooms	N	Number of classrooms	N
			Grade 9[a]				
1	Rural	11	56	1	31	2	25
2	Rural	15	62	1	24	2	38
3	Urban	6	43	1	22	1	21
4	Urban	7	37	1	19	1	18
5	Urban	8	55	1	15	2	40
6	Urban	8	56	2	37	1	19
7	Rural	7	65	2	36	2	29
8	Urban	7	32	1	15	1	17
9	Urban	7	200	5	101	5	99
			Grade 11[b]				
1	Suburban	7	98	3	52	3	46
2	Urban	14	26	1	16	1	10
3	Suburban	14	106	3	53	3	53
4	Urban	9	186	4	85	5	101

[a]Group X $N = 300$; Group Y $N = 306$. [b]Group X $N = 206$; Group Y $N = 210$.

TABLE 3

Selected Characteristics of Grade 9 and Grade 11 Group X and Y Samples

Variable	Grade 9		Grade 11	
	Group X ($N = 300$)	Group Y ($N = 306$)	Group X ($N = 206$)	Group Y ($N = 210$)
Sex				
Males	51%	49%	62%	50%
Females	49	51	38	50
Racial/Ethnic				
Afro-American/Black	3	6	0	1
American Indian, Alaskan Native	1	1	1	0
Caucasian American/White	86	82	92	89
Mexican-American/Chicano	2	2	0	1
Asian-American, Pacific Islander	2	1	1	0
Puerto Rican, Cuban, other Hispanic origin	1	0	.5	0
Other	1	2	.5	1
I prefer not to respond	4	5	5	8

Note. Of the 577 Grade 9 students responding to the racial/ethnic question, 67 (12%) reported they were non-white. Twenty-nine of the 67 were in Group X, and 38 of the 67 were in Group Y. Of the 389 Grade 11 students responding to the racial/ethnic question, 14 (4%) reported they were non-white. The non-white students were equally divided between Group X and Group Y.

TABLE 4

Time and Group Differences in UNIACT Stanine Scores

	CD-i					Paper-and-Pencil				
	Time 1, Group X		Time 2, Group Y			Time 1, Group Y		Time 2, Group X		
Scale	Mean	SD	Mean	SD	Diff.[a]	Mean	SD	Mean	SD	Diff.[a]
					Grade 9[b]					
SC	5.6	1.9	5.3	2.1	0.3	5.2	2.0	5.5	2.3	-0.3
AR	5.7	2.0	5.8	2.2	-0.1	5.3	2.0	5.8	2.1	-0.5
SS	5.4	2.3	5.8	2.3	-0.4	5.7	2.2	5.6	2.5	0.1
BC	5.1	2.0	5.4	2.1	-0.3	5.4	2.1	5.2	2.2	0.2
BO	4.5	2.1	5.1	2.4	-0.6	5.2	2.2	4.8	2.5	0.4
TE	5.0	2.1	5.1	2.2	-0.1	5.1	2.1	5.3	2.4	-0.2
					Grade 11[c]					
SC	5.3	2.0	5.6	2.0	-0.3	5.4	1.9	5.1	2.2	0.3
AR	5.4	2.0	6.0	2.1	-0.6	5.6	2.1	5.3	2.2	0.3
SS	5.2	2.2	5.6	2.2	-0.4	5.7	2.1	5.4	2.3	0.3
BC	5.2	2.0	5.2	2.0	0.0	5.2	2.0	5.2	2.2	0.0
BO	4.6	2.2	4.5	2.3	0.1	4.5	2.2	4.6	2.4	-0.1
TE	4.6	2.3	4.5	2.4	0.1	4.4	2.1	4.8	2.4	-0.4

[a]Difference between Time 1 and Time 2 mean UNIACT scores. [b]Group X N = 300; Group Y N = 306. [c]Group X N = 206; Group Y N = 210.

TABLE 5

Time and Group Differences in IWRA Job Cluster Scores

	CD-i					Paper-and-Pencil				
	Time 1, Group Y		Time 2, Group X			Time 1, Group X		Time 2, Group Y		
Scale	Mean	SD	Mean	SD	Diff[a]	Mean	SD	Mean	SD	Diff[a]
					Grade 9[b]					
SC	52.8	14.4	50.2	16.2	2.6	49.6	15.9	52.8	14.7	-3.2
AR	50.3	13.5	51.1	14.0	-0.8	51.4	14.3	51.9	14.4	-0.5
SS	43.3	14.9	45.0	14.7	-1.7	45.2	15.9	45.6	16.1	-0.4
BC	49.1	14.6	48.0	14.3	1.1	46.6	14.7	50.3	15.6	-3.7
BO	47.6	15.3	45.1	15.0	2.5	43.5	15.6	46.6	14.6	-3.1
TE	46.0	12.5	44.5	14.5	1.5	44.5	14.6	48.0	13.3	-3.5
					Grade 11[c]					
SC	51.6	15.6	49.3	14.5	2.3	49.6	14.0	51.9	14.6	-2.3
AR	51.1	14.4	48.6	14.1	2.5	50.1	14.7	53.4	14.1	-3.3
SS	45.2	12.9	43.3	14.9	1.9	45.3	15.1	47.8	14.2	-2.5
BC	49.7	14.1	48.0	12.8	1.7	49.0	13.4	50.7	14.1	-1.7
BO	47.4	14.1	43.8	13.6	3.6	44.8	14.1	47.4	13.6	-2.6
TE	43.1	13.7	44.9	13.2	-1.8	45.5	14.2	44.9	14.3	0.6

[a]Difference between Time 1 and Time 2 mean IWRA scores. [b]CD-i: Group Y N = 305-306; Group X N = 300. Paper-and-pencil: Group X N = 297-298; Group Y N = 304-306. [c]CD-i: Group Y N = 209-210; Group X N = 205-206. Paper-and-pencil: Group X N = 205-206; Group Y N = 304-306.

TABLE 6

Cross-Mode Scale Correlations for UNIACT and IWRA

	UNIACT		IWRA	
Scale	Grade 9[a]	Grade 11[b]	Grade 9[c]	Grade 11[d]
SC	.87	.87	.78	.75
AR	.84	.90	.72	.78
SS	.79	.81	.74	.69
BC	.80	.78	.72	.77
BO	.80	.82	.72	.74
TE	.81	.82	.71	.76

Note. The testing interval ranged from 6-15 days for Grade 9 and 7-14 days for Grade 11.

[a]$N = 606$. [b]$N = 416$. [c]$N = 601\text{-}605$. [d]$N = 413\text{-}415$.

TABLE 7

Correlations Among UNIACT Scale Scores: CD-i and Paper-and-Pencil Modes

	UNIACT Scale					
Scale	SC	AR	SS	BC	BO	TE
			Grade 9[a]			
SC	--	.25	.24	.16	.01	.35
AR	.26	--	.37	.23	-.05	.22
SS	.19	.38	--	.54	.23	.16
BC	.17	.26	.56	--	.51	.18
BO	.04	-.01	.24	.46	--	.30
TE	.30	.30	.20	.21	.29	--
			Grade 11[b]			
SC	--	.18	.23	.13	.04	.28
AR	.18	--	.39	.09	-.15	.32
SS	.23	.32	--	.41	.14	.18
BC	.14	.05	.42	--	.49	.07
BO	-.02	-.20	.15	.39	--	.24
TE	.29	.34	.17	.04	.21	--

Note. Paper-and-pencil correlations are shown above the diagonals; CD-i correlations are below the diagonals.

[a]$N = 606$. [b]$N = 416$.

TABLE 8

Correlations Among IWRA Job Cluster Scale Scores: CD-i and Paper-and-Pencil Modes

	Job Cluster Ability Scale					
Scale	SC	AR	SS	BC	BO	TE
			Grade 9[a]			
SC	--	.56	.51	.65	.62	.60
AR	.53	--	.65	.54	.47	.39
SS	.53	.64	--	.59	.54	.16
BC	.68	.52	.60	--	.70	.38
BO	.57	.43	.56	.72	--	.46
TE	.57	.37	.14	.38	.38	--
			Grade 11[b]			
SC	--	.49	.45	.63	.66	.53
AR	.47	--	.61	.43	.37	.35
SS	.46	.60	--	.54	.43	.10
BC	.64	.44	.52	--	.67	.35
BO	.61	.35	.47	.70	--	.51
TE	.55	.33	.04	.35	.42	--

Note. Paper-and-pencil are shown above the diagonals; CD-i correlations are below the diagonals.

[a]N = 599-606. [b]N = 413-416.

TABLE 9

Grade 9 UNIACT Scale Loadings on the First Three Principal Components for Two Principal Component Analyses (Paper-and-Pencil and CD-i)

	Paper-and-pencil			CD-i		
Scale	Response Set	Data/Ideas	Things/People	Response Set	Data/Ideas	Things/People
Science	.50	-.56	.32	.46	-.55	.31
Arts	.52	-.54	-.36	.59	-.51	-.33
Social Service	.74	-.01	-.44	.74	.07	-.45
Business Contact	.77	.38	-.23	.77	.37	-.21
Business Operations	.56	.67	.29	.54	.64	.38
Technical	.56	-.19	.67	.59	-.22	.58
			Summary statistics			
Eigen value	2.28	1.24	1.01	2.34	1.17	.94
Percent variance[a]	38.0	20.6	16.9	39.0	19.6	15.7
Percent variance [b]		33.2	27.3		32.1	25.7

[a]Percentage of variance accounted for in principal component analysis. [b]Percentage of variance accounted for by the Data/Ideas and Things/People dimensions after variance associated with response style was removed.

TABLE 10

Grade 11 UNIACT Scale Loadings on the First Three Principal Components for Two Principal Component Analyses (Paper-and-Pencil and CD-i)

	Paper-and-pencil			CD-i		
Scale	Response Set	Data/Ideas	Things/People	Response Set	Data/Ideas	Things/People
Science	.50	-.30	.37	.54	-.30	.17
Arts	.52	-.63	-.26	.51	-.63	-.21
Social Service	.73	-.11	-.48	.74	.05	-.45
Business Contact	.66	.53	-.29	.61	.55	-.31
Business Operations	.48	.72	.28	.38	.73	.42
Technical	.57	-.25	.61	.59	-.29	.65
			Summary statistics			
Eigen value	2.04	1.37	.97	1.95	1.40	.97
Percent variance[a]	34.1	22.9	16.2	32.5	23.4	16.1
Percent variance[b]		34.7	24.6		34.7	23.8

[a]Percentage of variance accounted for in principal component analysis. [b]Percentage of variance accounted for by the Data/Ideas and Things/People dimensions after variance associated with response style was removed.

TABLE 11

Grade 9 UNIACT Scale Targeted Factor[a] Loadings on the First Three Factors

	Paper-and-pencil			CD-i		
Scale	Data/Ideas	Things/People	Response Set	Data/Ideas	Things/People	Response Set
Science	-.49	.23	.61	-.49	.22	.59
Arts	-.49	-.39	.55	-.47	-.37	.59
Social Service	.07	-.61	.63	.10	-.61	.63
Business Contact	.51	-.36	.65	.48	-.37	.65
Business Operations	.71	.20	.52	.68	.23	.53
Technical	-.04	.55	.67	-.05	.49	.69
			Summary statistics			
Eigen value	1.24	1.04	2.22	1.17	.99	2.27
Percent variance[b]	20.8	17.4	36.9	19.5	16.5	37.9
Percent variance[c]	33.0	27.6		31.4	26.6	

[a]Cooley-Lohnes (1971, pp. 137-143) computer program for extracting pre-specified factors from a set of intercorrelations. [b]Percentage of variance accounted for in principal component analysis. [c]Percentage of variance accounted for by the Data/Ideas and Things/People dimensions after variance associated with response style was removed.

TABLE 12

Grade 11 UNIACT Scale Targeted Factor[a] Loadings on the First Three Factors

	Paper-and-pencil			CD-i		
Scale	Data/Ideas	Things/People	Response Set	Data/Ideas	Things/People	Response Set
Science	-.45	.25	.57	-.46	.22	.56
Arts	-.55	-.34	.52	-.58	-.31	.48
Social Service	-.03	-.60	.63	.01	-.59	.64
Business Contact	.56	-.34	.59	.53	-.37	.57
Business Operations	.71	.25	.50	.71	.28	.47
Technical	-.13	.52	.65	-.17	.52	.65
			Summary statistics			
Eigen value	1.33	.99	2.02	1.36	.98	1.92
Percent variance[b]	22.2	16.5	33.6	22.7	16.4	32.0
Percent variance[c]	34.4	24.8		33.4	24.1	

[a]Cooley-Lohnes (1971, pp. 137-143) computer program for extracting pre-specified factors from a set of intercorrelations. [b]Percentage of variance accounted for in principal component analysis. [c]Percentage of variance accounted for by the Data/Ideas and Things/People dimensions after variance associated with response style was removed.

TABLE 13

Mean UNIACT Stanine Scores and Reliabilities

	CD-i		Paper-and-pencil			Reliability[a]	
Scale	Mean	SD	Mean	SD	Difference[b]	CD-i	PP[c]
			Grade 9				
SC	5.4	2.0	5.3	2.2	-0.1	.91	.92
AR	5.8	2.1	5.6	2.1	-0.2	.87	.87
SS	5.6	2.3	5.6	2.3	0.0	.87	.87
BC	5.2	2.0	5.3	2.1	0.1	.84	.86
BO	4.8	2.2	5.0	2.4	0.2	.90	.91
TE	5.0	2.2	5.2	2.2	0.2	.85	.86
			Grade 11				
SC	5.4	2.0	5.3	2.1	-0.1	.91	.91
AR	5.7	2.1	5.4	2.2	-0.3	.87	.88
SS	5.4	2.2	5.6	2.2	0.2	.83	.85
BC	5.2	2.0	5.2	2.1	0.0	.82	.84
BO	4.6	2.2	4.6	2.3	0.0	.90	.91
TE	4.6	2.3	4.6	2.3	0.0	.87	.86

Note. For means and standard deviations, $N = 606$ and 416 for Grades 9 and 11, respectively. For CD-i and paper-and-pencil reliabilities, Ns = 604 and 596, respectively, for Grade 9; and Ns = 413 and 410, respectively, for Grade 11.

[a]Cronbach's (1951) coefficient alpha. [b]Mean differences. [c]Paper-and-pencil.

TABLE 14

Grade 9 Male and Female Mode of Presentation Differences for UNIACT

	CD-i		Paper-and-Pencil		
Scale	Mean	SD	Mean	SD	Diff[a]
		Males (N = 301)			
SC	14.9	8.6	14.2	9.1	0.7
AR	16.7	7.1	15.9	7.3	0.8
SS	18.8	7.3	19.0	7.2	-0.2
BC	14.4	6.9	14.4	7.1	0.0
BO	11.2	7.7	11.8	8.1	-0.6
TE	14.6	7.2	15.1	7.5	-0.5
		Females (N = 305)			
SC	13.1	8.9	12.9	8.8	0.2
AR	18.9	7.8	18.6	7.8	0.3
SS	23.4	5.4	23.5	5.5	-0.1
BC	15.0	7.0	15.6	7.4	-0.6
BO	12.0	8.4	12.8	8.9	-0.8
TE	10.4	6.9	10.8	7.0	-0.4

Note. Means and SDs based on raw scores ranging from 0-30.

[a]Mean differences. Male and female mean absolute differences were 0.5 and 0.4, respectively.

TABLE 15

Grade 11 Male and Female Mode of Presentation Differences for UNIACT

	CD-i		Paper-and-pencil		
Scale	Mean	SD	Mean	SD	Diff[a]
		Males (N = 233)			
SC	14.8	8.8	14.0	8.9	0.8
AR	17.5	8.0	16.2	8.0	1.3
SS	19.8	6.8	20.3	7.0	-0.5
BC	15.6	6.9	15.6	7.4	0.0
BO	12.2	8.3	12.7	8.5	-0.5
TE	13.5	7.6	13.6	7.2	-0.1
		Females (N = 183)			
SC	13.7	9.2	13.3	9.1	0.4
AR	18.7	7.9	18.0	8.3	0.7
SS	24.5	5.0	24.5	5.3	0.0
BC	16.0	7.0	15.8	7.2	0.2
BO	11.0	8.8	10.7	8.8	0.3
TE	8.9	7.4	9.3	7.5	-0.4

Note. Means and SDs based on raw scores ranging from 0-30.

[a]Mean difference. Male and female mean absolute differences were 0.5 and 0.3, respectively.

TABLE 16

IWRA Job Cluster Scale Scores and Reliabilities

	CD-i		Paper-and-pencil			Reliability[a]	
Scale	Mean	SD	Mean	SD	Difference[b]	CD-i	PP[c]
			Grade 9				
SC	51.5	15.4	51.2	15.4	-.03	.60	.59
AR	50.7	13.7	51.7	14.3	1.0	.51	.59
SS	44.1	14.8	45.4	16.0	1.3	.60	.66
BC	48.6	14.4	48.5	15.3	-0.1	.56	.58
BO	46.4	15.2	45.1	15.1	-1.3	.63	.62
TE	45.2	13.5	46.3	14.1	1.1	.56	.60
			Grade 11				
SC	50.4	15.1	50.7	14.3	-0.3	.60	.53
AR	49.9	14.3	51.8	14.5	1.9	.57	.63
SS	44.3	13.9	46.6	14.7	2.3	.58	.62
BC	48.9	13.5	49.9	13.8	1.0	.47	.49
BO	45.6	13.9	46.2	13.9	0.6	.57	.56
TE	44.0	13.5	45.2	14.2	1.2	.60	.67

Note. For means and standard deviations, N = 602-606 for Grade 9, and N = 414-416 for Grade 11. For CD-i and paper-and-pencil reliabilities, Ns = 604 and 596, respectively, for Grade 9; and Ns = 413 and 410, respectively, for Grade 11.

[a]Cronbach's (1951) coefficient alpha. [b]Mean differences. [c]Paper-and-pencil.

TABLE 17

Grade 9 IWRA Mean Scaled Scores

Ability	CD-i		Paper-and-pencil		
	Mean	SD	Mean	SD	Difference[a]
Meeting People	4.1	2.1	4.5	2.3	0.4
Helping Others	4.2	2.1	4.4	2.2	0.2
Sales	4.5	2.1	4.6	2.3	0.1
Leadership	5.0	2.2	4.9	2.4	-0.1
Organization	4.6	2.3	4.6	2.3	0.0
Clerical	4.1	2.0	3.6	2.0	-0.5
Mechanical	4.0	1.9	4.3	1.9	0.3
Manual Dexterity	4.4	1.8	4.4	1.9	0.0
Numerical	5.1	2.3	5.0	2.3	-0.1
Scientific	5.8	2.3	5.8	2.4	0.0
Artistic	5.6	2.0	5.6	2.0	0.0
Literary	4.8	2.3	4.9	2.2	0.1
Reading	4.6	2.3	4.4	2.3	-0.2
Language Usage	4.7	2.2	4.8	2.2	0.1
Spatial Perception	5.1	2.2	5.2	2.1	0.1

Note. $N = 606$. The overall paper-and-pencil and CD-i means are 4.73 and 4.71, respectively.

[a]Mean difference. Mean absolute across the 15 means is 0.15.

TABLE 18

Grade 11 IWRA Mean Scaled Scores

Ability	CD-i		Paper-and-pencil		
	Mean	SD	Mean	SD	Difference[a]
Meeting People	4.3	2.0	4.6	2.2	0.3
Helping Others	4.2	2.0	4.7	2.1	0.5
Sales	4.7	2.1	4.8	2.3	0.1
Leadership	5.3	2.1	5.1	2.2	-0.2
Organization	4.7	2.2	4.7	2.3	0.0
Clerical	4.1	1.8	3.7	1.9	-0.4
Mechanical	3.7	1.9	4.0	1.9	0.3
Manual Dexterity	4.2	1.9	4.1	1.9	-0.1
Numerical	4.8	2.3	4.9	2.3	0.1
Scientific	5.8	2.4	6.0	2.4	0.2
Artistic	5.2	2.2	5.3	2.2	0.1
Literary	5.1	2.3	5.2	2.2	0.1
Reading	4.5	2.2	4.2	2.2	-0.3
Language Usage	4.6	2.1	5.0	2.1	0.4
Spatial Perception	5.0	2.1	5.1	2.0	0.1

Note. $N = 416$. The overall paper-and-pencil and CD-i means are 4.77 and 4.68, respectively.

[a]Mean difference. Mean absolute across the 15 means is 0.21.

Grade 9

	Time One	Time Two
Group X	I(CD-i) + A(PP)	I(PP) + A(CD-i)
Group Y	I(PP) + A(CD-i)	I(CD-i) + A(PP)

Grade 9 Modified

	Time One	Time Two
Group X	I(CD-i) + A(PP)	A(CD-i) + I(PP)
Group Y	A(CD-i) + I(PP)	I(CD-i) + A(PP)

Grade 11

	Time One	Time Two
Group X	I(CD-i) + A(PP)	A(CD-i) + I(PP)
Group Y	A(CD-i) + I(PP)	I(CD-i) + A(PP)

Note. **I** = interests; **A**= ability self-estimates; **PP** = paper-and-pencil; **CD-i** = Compact Disc-Interactive.

Figure 1. Research designs.

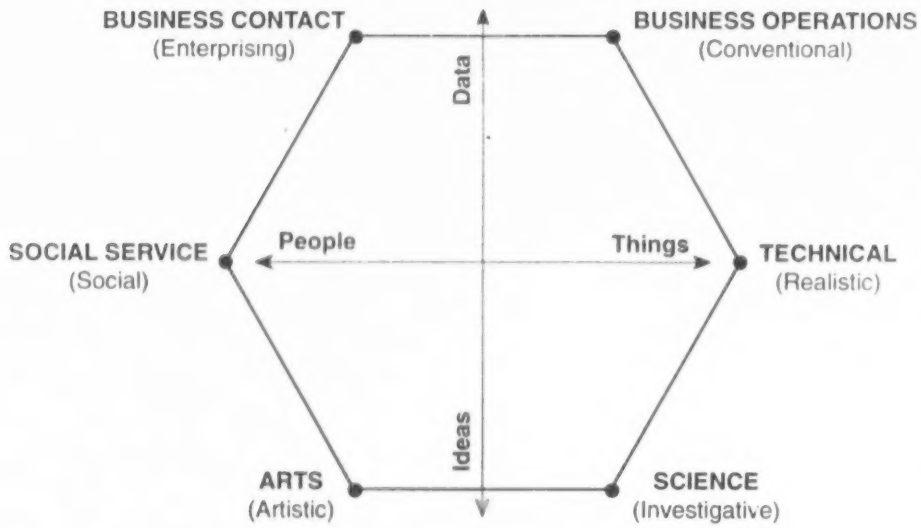

Figure 2. Relationship between UNIACT scales and Data/Ideas and Things/People Work Task Dimensions. Holland types corresponding to UNIACT scales are shown in parentheses.

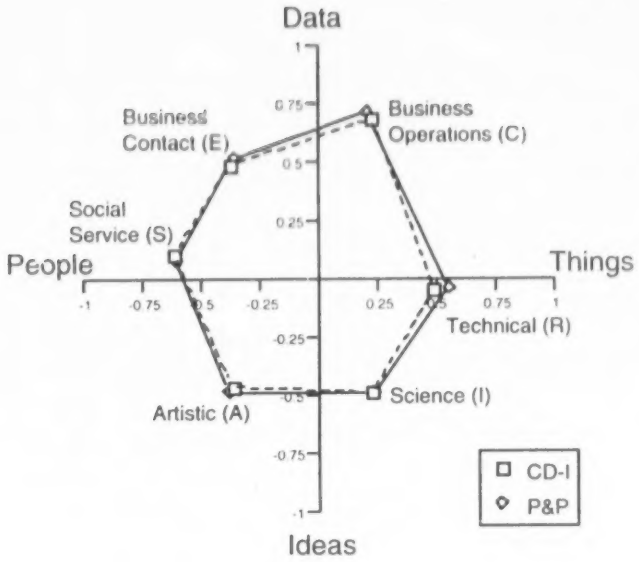

Figure 3. Plot of UNIACT theory-based factor loadings for Grade 9.

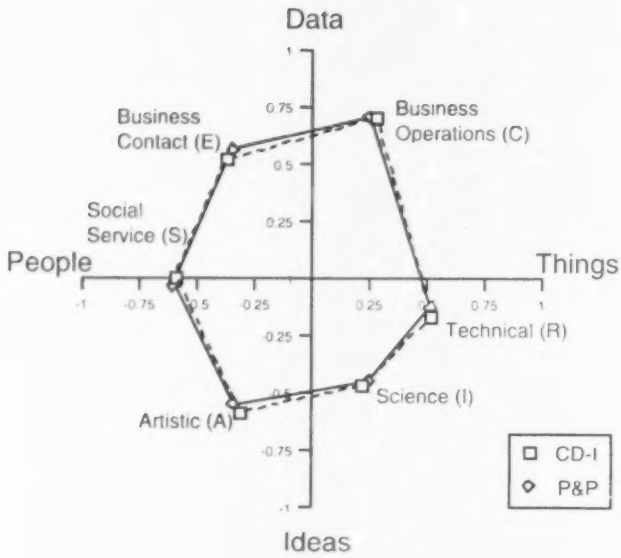

Figure 4. Plot of UNIACT theory-based factor loadings for Grade 11.

BEST COPY AVAILABLE